



# DoD Space Transportation Perspective

NASA Exploration Transportation  
Strategic Roadmap  
Federal Advisory Committee Meeting #1  
3-4 February 2005  
Orlando, Florida

**Colonel Jim Knauf**  
**Chief, Space Support & Force Application**  
**Directorate of Space Acquisition**  
**Office of the Undersecretary of the Air Force**

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# *Overview*

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- **Space Transportation Environment – DoD perspective**
- **EELV**
- **Operationally Responsive Launch**
- **Next generation space transportation**
- **Space launch ranges**

# ***Environment – DoD Perspective***

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- **Increasing dependence on space for national security**
- **Consequent need for assured access to space**
  - Backup capability
  - Protection of half of manifest
  - Industrial base
- **Warfighter need for responsiveness**
  - Augmentation or reconstitution of existing capabilities
  - High level interest, intensifying definition
- **Anemic commercial launch market**
- **Extremely challenging fiscal environment**

**Robust  
Responsive  
Resilient**

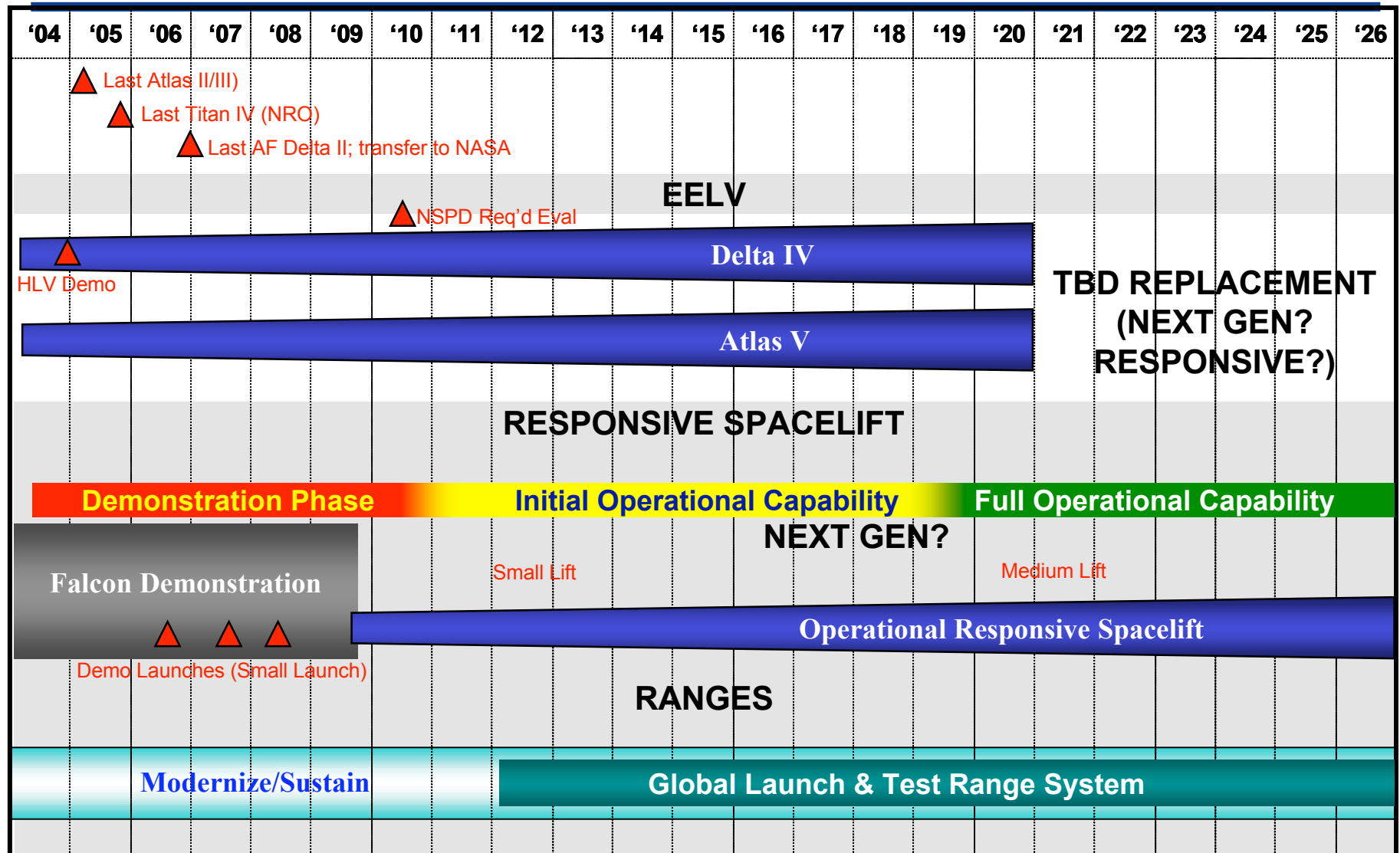
**Emerging Need for Responsive, Assured Access to Space  
Challenging Environment**

## ***Space Transportation – Feb 2005 Snapshot***

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- **Fly out remaining Delta II and Titan IVs**
  - **Transition to EELVs and sustain through ~2020**
    - **Extend if cost effective, or develop alternative**
  - **Demonstrate, develop, deploy ORS capability by 2010**
  - **Transform launch and test ranges into responsive global launch and test range**
  - **Leverage (and define?) “next generation” space transportation technology**
    - **Work with NASA (pending requirements)**
    - **Focus on breakthrough technologies**
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# DoD Space Transportation Roadmap





**Eutelsat  
Hotbird 6  
Atlas V  
21 Aug 02**



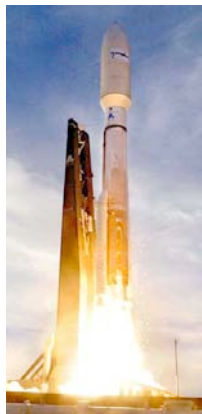
**Eutelsat  
W5  
Delta IV  
20 Nov 02**



**DSCS A3  
Delta IV  
10 Mar 03**



**Hellas Sat  
Atlas V  
13 May 03**



**Rainbow 1  
Atlas V  
17 Jul 03**



**DSCS B6  
Delta IV  
29 Aug 03**



**AMC-16  
Atlas V  
(521) 17  
Dec 04**



**HLV-Demo  
Delta IV  
21 Dec 04**

\* Evaluating early  
MECO anomaly

**8 successful launches to date\***

- 
- **26 NSS missions + HLV Demo contracted (3 flown)**
  - **AF revising acquisition strategy from commercial approach to more traditional**
    - **Fixed infrastructure plus launch services**
    - **TBR: infrastructure cost sharing for non-AF / NRO**
  - **Existing Delta IV and Atlas V design variants meet known national security requirements**
    - **Growth variants could support NASA needs**

**Delta IV, Atlas V can provide space transportation infrastructure to meet both DoD and NASA needs**

# ***Responsive Spacelift***

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- **Key element is "Responsiveness"**
  - **Hours to days vs. weeks to months to launch**
- **First step: demonstrate responsive launch capability (Small Launch) via Falcon demonstration program**
- **Develop, test, produce operational capability by 2010**
- **Working responsive payloads, C2, and CONOPS in parallel**
  - **Demonstrate military utility/support warfighter**

**Operationally Responsive Spacelift CONOPs Development and Demonstration of Military Utility are Underway**

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# *Falcon Small Launch Vehicle*



## **AF / DARPA / NASA Demonstration**

### **SLV Operational System:**

- **Small Payloads to LEO**
  - 1000 lb payload to 28.5°, circular, 100 nm altitude (baseline orbit for concept comparison)
  - Technologies support payload growth options
- **Low Recurring Launch Cost (< \$5M)**
- ♣ **New Launch Operations**
  - ♣ Reach alert status within 24 hrs
  - ♣ Launch within 24 hrs

# *Ranges*

- **Essential aspect of space transportation**
- **Upgrades and sustainment last 10 years have focused on modernization / sustainment of existing capabilities**
- **Joint AF / NASA (+ others) Advanced Range Technology Working Group**
  - **Identify technology needs**
  - **Develop roadmap**
  - **Develop plan approaches and options for next generation ranges**



**Transformation of Ranges needed to support responsive space**

## ***Next Generation / S & T (Examples)***

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- **Cooperative technology efforts w/NASA**
  - **Integrated High Payoff Rocket Propulsion Technology Program: 3 phase, 15 year national program to double space /missile propulsion capability, decrease cost and increase reliability by 2010**
  - **Hypersonics: X-43 hydrocarbon scramjet**
- **SMC, AFRL, AFSPC - Affordable Responsive Spacelift (ARES):**
  - **10K LEO Hybrid (1<sup>st</sup> Stage Reusable / 2<sup>nd</sup> Stage Expendable)**
- **DARPA – RASCAL, Falcon (w/AF & NASA)**
- **AFRL**
  - **AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch Vehicle Technology**

**“Holy Grail:” The Space Analogy of Aviation’s Jet Engine**

# *Conclusion*

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- **DoD needs Assured Access and Responsive Launch, therefore...**
- **Need two EELV providers; intend to support consistent w/NSPD**
  - **Also an enabler for evolving NASA needs**
- **Need Operationally Responsive Launch by 2010**
  - **Potential start on next generation space transportation**
- **Need to work with NASA on EELV evolution and next generation**
  - **Pending determination of NASA requirements;**
  - **Focus “next generation” on breakthrough technologies**
- **Space launch range modernization/evolution consistent w/above**

**DoD is ready to work with NASA to support space transportation needs**

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# ***Backups***

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# ***Delta IV HLV Demo***

## ***21 Dec 2004***


































































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- **Demonstration met primary objectives**
    - **Activating and launching HLV from Delta IV launch pad**
    - **Flying three common booster cores (CBC)**
    - **Separating 2 strap-on CBCs from the center CBC**
    - **Flying/separating 1st 5-meter diam. composite payload fairing**
    - **Flying 1st 5-meter diam. cryogenic upper stage through a long duration, 3-burn profile of the RL10B-2 engine**
  - **Premature MECO on core and strap-on CBCs**
  - **Fault tree analysis underway**
    - **Apparent cavitation-type disturbance in LOX flow; engine cutoff sensors reacted, falsely indicating LOX depletion**
    - **Aiming for fault tree closeout and identify cause by mid-Feb**
  - **Next mission (DSP-23) still scheduled for Aug 2005**
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**NOTES:**

- Buy 1 Launches are **red** and **ordered are underlined**
- Buy 2 missions
- Buy 2.5
- Buy 3 proposed in **blue box**






# EELV Launch Schedule

EELV	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Boeing Delta IV CCAFS SLC-37B		 HLV Demo Dec	 DSP 23 Aug	 NRO WGS #1 (5,4) Dec	 GPS IIF-1 (4,0) Nov	 GPS IIF-5 (4,0) Jul	 GPS IIF-9 (4,0) Dec	 GPS IIF-10 (4,0) Apr	 SBIRS G3 (4,2) Jun																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
Boeing Delta IV VAFB SLC-6		 NRO L-22 (4,2) Jul	 DMSP #17 (4,0) Aug	 NRO L-25 (4,0) Mar																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Lockheed-Martin Atlas V CCAFS SLC-41			 WGS #2 (521) NET Jun	 NRO L-30 (501) Mar	 STP #1 (401) Sep	 WGS #3 (521) NET Nov	 GPS IIF-2 (401) Jan	 NRO L-24 (401) Jul	 GPS IIF-3 (401) Oct	 GPS IIF-4 (401) Dec	 GPS SBIRS G1 (401) Jun	 GPS IIF-6 (401) Jan	 GPS SBIRS G2 (401) Jun	 GPS IIF-7 (401) May	 GPS IIF-8 (401) Oct																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
Lockheed-Martin Atlas V VAFB SLC-3E			 NRO L-28 (411) May	 NRO L-29 (tbd) Jul	 NRO L-41 (501) Sep	 DMSP #18 (401) Oct	 NRO L-39 (501) NET Oct	 NRO L-45 (501) NET Oct																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
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CCAFS					 AEHF-1 Apr	 NROL-32 Oct	 AEHF-2 Apr	 WGS-4 Jun	 NROL-34 Jul	 NROL-27 Jan	 MUOS-1	 AEHF-3 Apr	 WGS-5 Jun	 STP-2 Apr	 NROL-15 Apr	 NROL-38 Oct	 MUOS-2	 GPS IIF-11 Oct	 GPS IIF-12 Jan	 GPS IIF-13 Apr	 STTR-1 Jan	 MUOS-3	 GPS IIF-14 Oct	 GPS IIF-15 Mar	 GPS IIF-16 Aug	 SBIRS-G4 Jun	 SBSS-1&2 Jun	 NROL-36 NET Jan	 NROL-46 NET Jan	 NROL-33 NET Jul	 GPS III-1 Jun	 GPS IIF-17 Dec	 GPS IIF-18 Apr	 GPS IIF-19 Sep	 SBIRS-G5 Jun	 TSAT-1 Mar	 ODSI 1a&b Jan																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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As of: 14 Jan 05

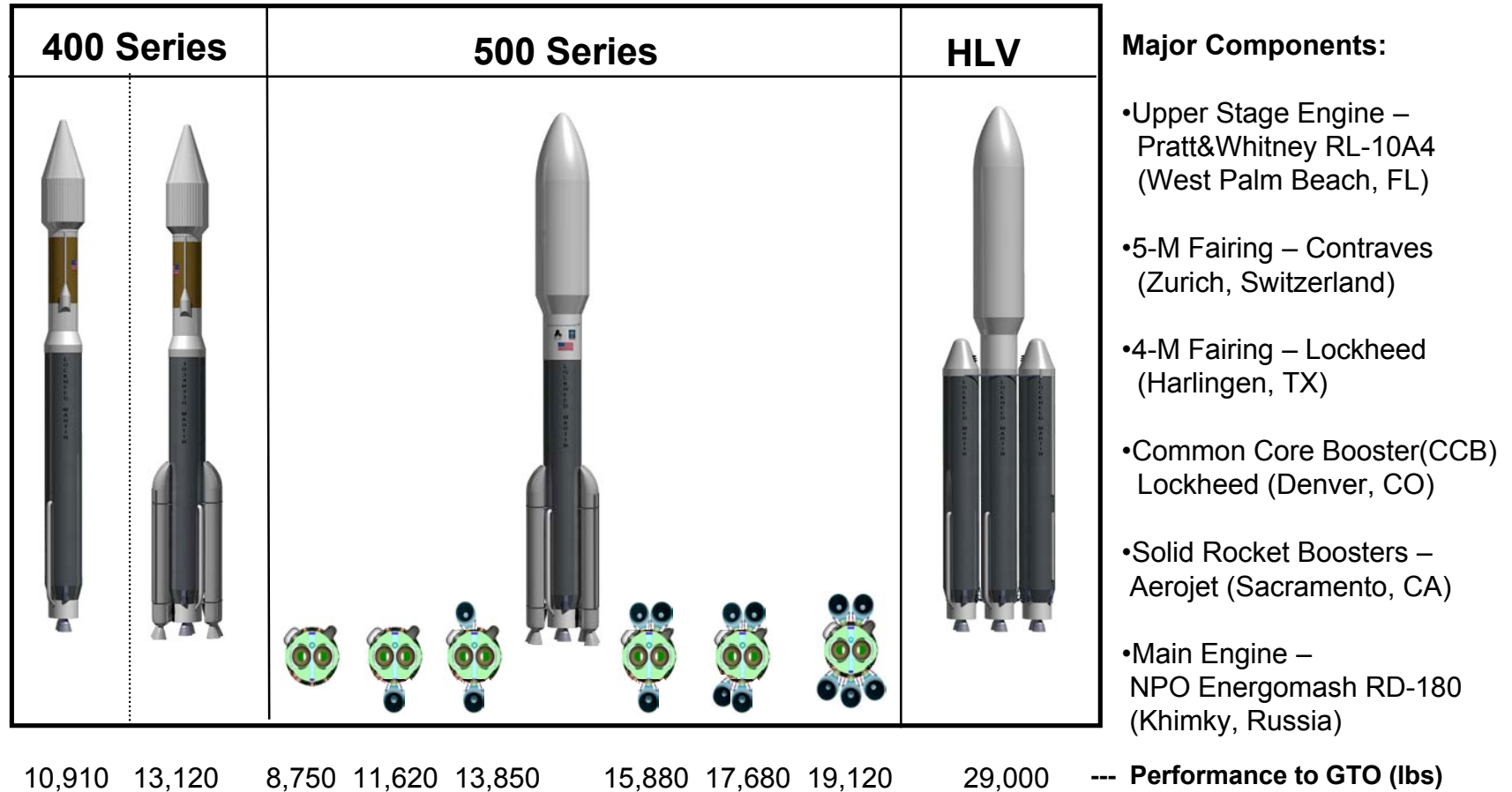
# EELV

## Boeing Delta IV Family

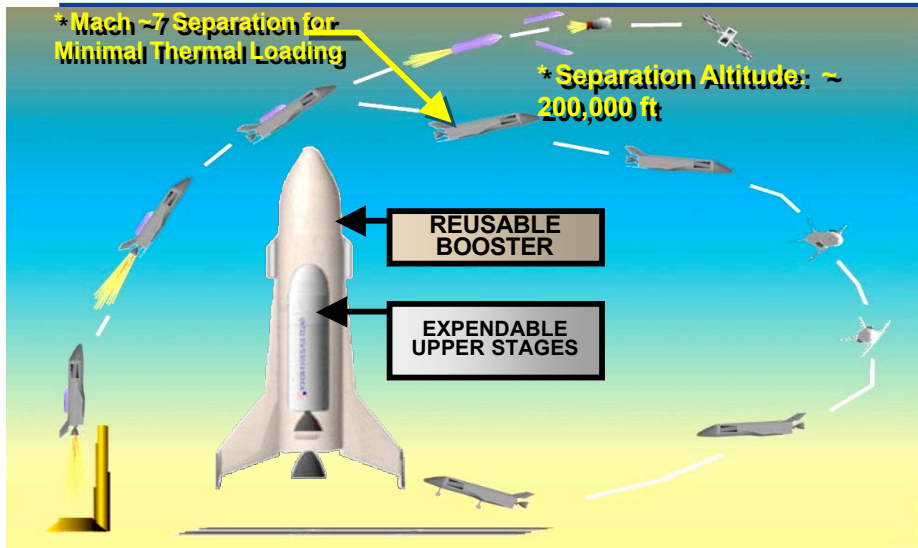
DELTA IV MEDIUM	DELTA IV MEDIUM +				DELTA IV HEAVY	Major Components:
						
DIV-Med	DIV-Med+ (4, 2)	DIV-Med+ (5, 2)	DIV-Med+ (5, 4)		DIV-Hvy	<ul style="list-style-type: none"> <li>•Upper Stage Engine – Pratt&amp;Whitney RL-10B2 (West Palm Beach, FL)</li> <li>•5-M Fairing – Alliant Techsystems (Iuka, MS)</li> <li>•4-M Fairing – Boeing (Pueblo, CO)</li> <li>•Common Booster Core (CBC) Boeing (Decatur, AL)</li> <li>•GEM 60s – Alliant Techsystems (Magna, UT)</li> <li>•Main Engine – Rocketdyne RS-68 (Canoga Park, CA)</li> </ul>
9,285	12,890	10,230	14,475		23,950	--- Performance to GTO (lbs)

# EELV

## Lockheed-Martin Atlas V Family



# Affordable *RE*sponsive Spacelift (*ARES*)



## ■ Description

- 10K to LEO Hybrid Vehicle (1<sup>st</sup> Stage Reusable and 2<sup>nd</sup> Stage Expendable)
- Demonstrate affordable & responsive spacelift capability

## ■ Team

- **SMC/TD, AFSPC/DR, AFRL**

## ■ POCs

- TD Lead: Mr. Ken Hampsten

## ■ Status

- 15 Jul 04, AFROCC approved Operationally Responsive Spacelift Analysis of Alternatives (ORS AoA) results and recommends: Spiral development of hybrid sub-scale demo to full scale ops vehicle
- AFRL RSAT and S&T Vector 1 study results support ARES

## ■ Issues

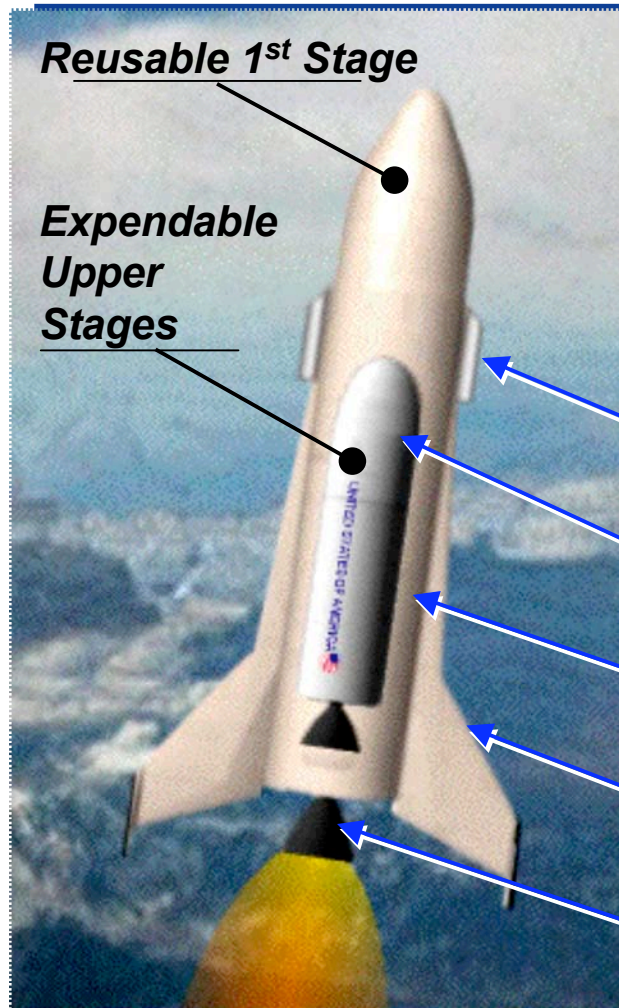
### ■ Solidify commitment

- Brief AFSPC/CC 24 Jan 05

### ■ Funding

- FY05-06 AFSPC and AFRL funds for concept development
- FY07-11 POM funds subscale design, build and demo

# ***ARES Overview***



## **Reusable 1<sup>st</sup> Stage with Expendable Upper Stages**

- Provides optimally-sized vehicle for cost and responsiveness

- Approx \$2,000 / lb to LEO

- 1-2 Day Turn Times

***Fly-Back Jet Engines***

***Adaptive GN&C***

***Mach 7 Separation***

***Integrated Warm Structure (no Shuttle TPS)***

***Long-Life Hydrocarbon Propulsion***

1/3 the  
development cost  
of a RLV

---  
1/3 the recurring  
cost of an ELV

***ARES reduces launch costs by a factor of 3***